Froedtert & Medical College of Wisconsin Clinical Cancer Center

Day Hospital Room Utilization Modeling and Simulation

1. Project Overview

Introduction

The Froedtert & Medical College of Wisconsin Clinical Cancer Center includes a Day Hospital for patients needing chemotherapy, blood products, and other types of infusions or advanced services which might otherwise require hospitalization. The Day Hospital offers different treatment settings to fit the needs of individual patients. Twenty semi-private infusion stations let patients receive therapy in a light, open environment that allows for interaction with others. There are also 18 private infusion rooms for patients receiving longer treatments or who need more complex support.

Nurses' stations are located throughout the Day Hospital to ensure that patients are closely monitored, and each infusion area is connected to a nurse call system. Every care setting includes accommodations for the patient's family or friends, and every private room has direct access to a bathroom. The Day Hospital's private room facilities enable patients to receive the equivalent of inpatient care in an outpatient setting.

The Day Hospital enables many chemotherapy patients who would normally need to be hospitalized to receive medical treatments during the day and then go home in the evening. Many cancer patients struggle to balance their therapy needs with job and family responsibilities. To help patients maintain this balance, the Day Hospital is open seven days a week, with extended evening, weekend and holiday hours.

Situation

Chemotherapy is a complex process involving patient-specific treatments and medicines, both of which may be adapted while therapy is being received by the patient. This requires close patient monitoring by Day Hospital nurses, with input from the patient's physician as needed. Medicines are prepared by a Cancer Center pharmacy as they are consumed during therapy to prevent wastage of expensive materials. Assignment of a particular room for a specific patient is based on the procedures required for their therapy and also on patient room preferences.

Because of these conditions, the actual time that a patient spends in therapy can vary significantly from the ideal treatment time without delays or interruptions. This, of course, makes it very difficult to create and maintain a daily patient treatment schedule. The situation is aggravated by the fact that each patient has a fairly narrow time-slot within which their therapy must be administered, and further aggravated by an increasing Day Hospital patient load. Finally, the Day Hospital works on a single 12-hour shift (7:00AM to 7:00PM), which means that treatments on all patients scheduled for a particular day must be completed by the end of the day.

Problem

Two problems can result from this situation. If slack time is added to the daily schedule to allow for schedule changes, resource utilization will be reduced, which negatively impacts both treatment cost and the number of patients that can be treated in a day. If slack time is reduced, resource utilization may increase, but patients may spend excessive time waiting for treatment to start, and treatments may run over the end of the shift.

One potential solution is to increase the capacity of the Day Hospital (staff and facilities). A second solution is to experiment with different scheduling schemes to find a scheme which yields greater resource utilization without increasing patient wait times or requiring treatments to run beyond the end of the shift. Clearly, the second solution is desirable, but poses its own problems: experimentation with scheduling schemes could be disruptive to patients and staff, and some experimental schemes may temporarily worsen the situation.

Project Objectives

An alternative to the solutions outlined above is to create a computer model of the Day Hospital which simulates patient flow in the Day Hospital. The model would incorporate all of the major steps and decisions involved in a generic chemotherapy appointment, and would be driven by real and experimental schedules prepared by Day Hospital staff. Primary model outputs would be patient wait times and Day Hospital resource utilization (primarily rooms and nurses), with other outputs included as needed. The model would allow the results of various experimental scheduling schemes to be compared, and would allow the impact of resource changes to be predicted.

The results of these simulations would be used to determine if different scheduling schemes could increase resource utilization while maintaining or reducing patient wait times. Candidate schemes could then be implemented with some assurance that the predicted improvements would be realized. If no scheme exhibits adequate improvement, the model could be used to identify resource expansion requirements and predict results of various resource expansion scenarios.

Project Steps and Deliverables:

Given the complexity of chemotherapy, creating and applying the model described in the preceding section is no small task. Such an endeavor is often initiated by creating a simple as-is model of the system under study, and then validating the model by comparing model outputs with current system performance. This project will develop an as-is model for the Day Hospital chemotherapy treatment system. Major project steps are as follows:

1. Provide general description of the chemotherapy treatment system based on staff interviews.
2. Describe chemotherapy treatment system scope/boundaries (context diagram).
3. Describe relationships among all major system elements (entity relationship diagram).
4. Describe information flow through the system (entity flow diagram).
5. Describe patient flow through the system (state transition diagram).
6. Describe specific therapy process steps and decisions (process flow diagram).
7. Build and test the initial simulation model (Arena simulation model).
8. Obtain typical patient arrival schedules to drive the simulation model.
9. Obtain and/or estimate delay times for the model's process steps.
10. Compare simulation model results with actual Day Hospital performance.
11. Modify simulation model results as needed.
12. Summarize project results and propose next actions.

Each of these major steps comprises a project deliverable. Each project deliverable will be documented and delivered to the project sponsor upon completion.

Project Action Plan

Project execution will start with initial interviews of Day Hospital staff to obtain information for the first four project deliverables. Information will be converted to associated diagrams and verified with staff before simulation models are constructed.

The initial simulation model will be built and run using typical schedules but without estimates for delay times. Results will be shared with staff in preparation for the data gathering segment of the project.

Initial discussions indicate that data on actual delay times through the system is typically not recorded. Such data is essential to the model. The project team will need to decide on appropriate methods to obtain or estimate samples of these times.

With completion of the initial simulation model and access to actual schedules and actual or estimated delay times, model results can be compared to actual Day Hospital performance. If results vary significantly with the actual system performance, it will be necessary to review model accuracy and/or validate system delay times.

A summary of project results will be prepared and delivered as a presentation and as a report to interested parties at Froedtert and the Medical College of Wisconsin.

Project Team

Involvement of a number of Day Hospital staff members will be required to build and test the as-is model and to collect data required to drive the simulation. Lead team members for this project are:

- Holly Eglsaer, RN: Manager - Cancer Center Day Hospital, Froedtert & Medical College of Wisconsin
- Nicole Lutter, RN: Staff Nurse - Cancer Center Day Hospital, Froedtert & Medical College of Wisconsin
- Beth Lanham, RN: Director - Six Sigma, Froedtert & Medical College of Wisconsin
- Mark Polczynski, PhD: MS - Engineering Management Program, Marquette University (facilitator)
- Phil Weinfurt, PhD: MS - Health Care Technology Management Program, Marquette University

Additional team members will be added over the course of the project.